Claims

SUB A3

1. A semiconductor device comprising:
an insulator film formed on a substrate;
a wiring layer of copper formed on the insulator film; and
a copper diffusion preventing film, arranged between the insulator film and the wiring film, that prevents copper diffusion from the wiring layer to the insulator film.

2. The semiconductor device according to claim 1, wherein the copper diffusion preventing film is a crystalline film, and wherein the crystalline film, when subjected to X-ray diffraction, shows a spectrum having peaks at a first position between 36 degrees and 38 degrees and at a second position between 42 degrees and 44 degrees.

3. The semiconductor device of claim 2, wherein the copper diffusion preventing film is the crystalline film that a half-width of the peak at the first position between 36 degrees and 38 degrees is 3.2 degrees or less.

4. The semiconductor device of claim 2, wherein the copper diffusion preventing film is the crystalline film that a half-width of the peak at the second position between 42 degrees and 44 degrees is 2.6 degrees or less.

5. A semiconductor device comprising:
an insulator film formed on a substrate;
a wiring layer of copper formed on the insulator film; and
a copper diffusion preventing film that prevents copper diffusion from the wiring layer to the insulator film, the copper diffusion preventing film being formed of a film containing tungsten and carbon and being arranged between the insulator film and the wiring layer.

6. A method of making a semiconductor device comprising the steps of converting a gas containing tungsten, carbon, nitrogen and hydrogen into a plasma and forming a crystalline copper diffusion

preventing film by means of the plasma, the copper diffusion preventing film containing tungsten, carbon and nitrogen, the copper diffusion preventing film, when subjected to X-ray diffraction, showing peaks at a first position between 36 degrees and 38 degrees and at a second position between 42 degrees and 44 degrees,

wherein a process temperature during formation of the copper diffusion preventing film is 250°C or higher.

7. The method of making the semiconductor device according to claim 6, wherein the process temperature is 250°C to 500°C.

8. A method making a semiconductor device comprising the steps of converting a gas containing tungsten, carbon, nitrogen and hydrogen into a plasma and forming a crystalline copper diffusion preventing film by means of the plasma, the copper diffusion preventing film containing tungsten, carbon and nitrogen, the copper diffusion preventing film, when subjected to X-ray diffraction, showing peaks at a first position between 36 degrees and 38 degrees and at a second position between 42 degrees and 44 degrees,

wherein a process pressure during formation of the copper diffusion preventing film is 10 Pa or less.

9. The method of making the semiconductor device according to claim 8, wherein the process pressure is 5 Pa or less.

10. The method of making the semiconductor device according to any one of claims 6 to 9, wherein the gas containing tungsten, carbon, nitrogen and hydrogen includes a hydrocarbon gas.

11. The method of making the semiconductor device according to any one of claims 6 to 9, wherein the hydrocarbon gas has a multiple bond.

12. The method of making the semiconductor device according to any one of claims 6 to 9, wherein the gas containing tungsten, carbon, nitrogen and hydrogen includes a carbon-fluorine compound gas.

13. The method of making the semiconductor device according to any one of claims 6 to 9, wherein a plasma is generated by an interaction between a high frequency wave and a magnetic field, and the gas is converted into a plasma with use of the plasma.

Add A4